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(54) Bogie frame of rolling stock.

(57) A rolling-stock bogie frame has a ladder-shaped frame structure (1) comprising side beams and cross beams (15, 16; 17, 18, 19, 20), each of which has a trough-shaped part (27) with an open upper part (d) and a reinforcing member (22) secured to the trough-shaped part (27) to cover and close the open upper part thereby to form a closed box beam with a utilizable hollow interior (i). Each of the trough-shaped part (27) and reinforcing member (22) comprises spaced apart inner and outer sheathings (a, g; b, h) of fiber-reinforced plastic material and honeycomb members (21) inserted between and bonded to the inner and outer sheathings. The bogie frame affords high strength with low weight. The hollow interior of the beam provides an equipment space for accommodating an air reservoir and piping for the pneumatic and hydraulic systems.

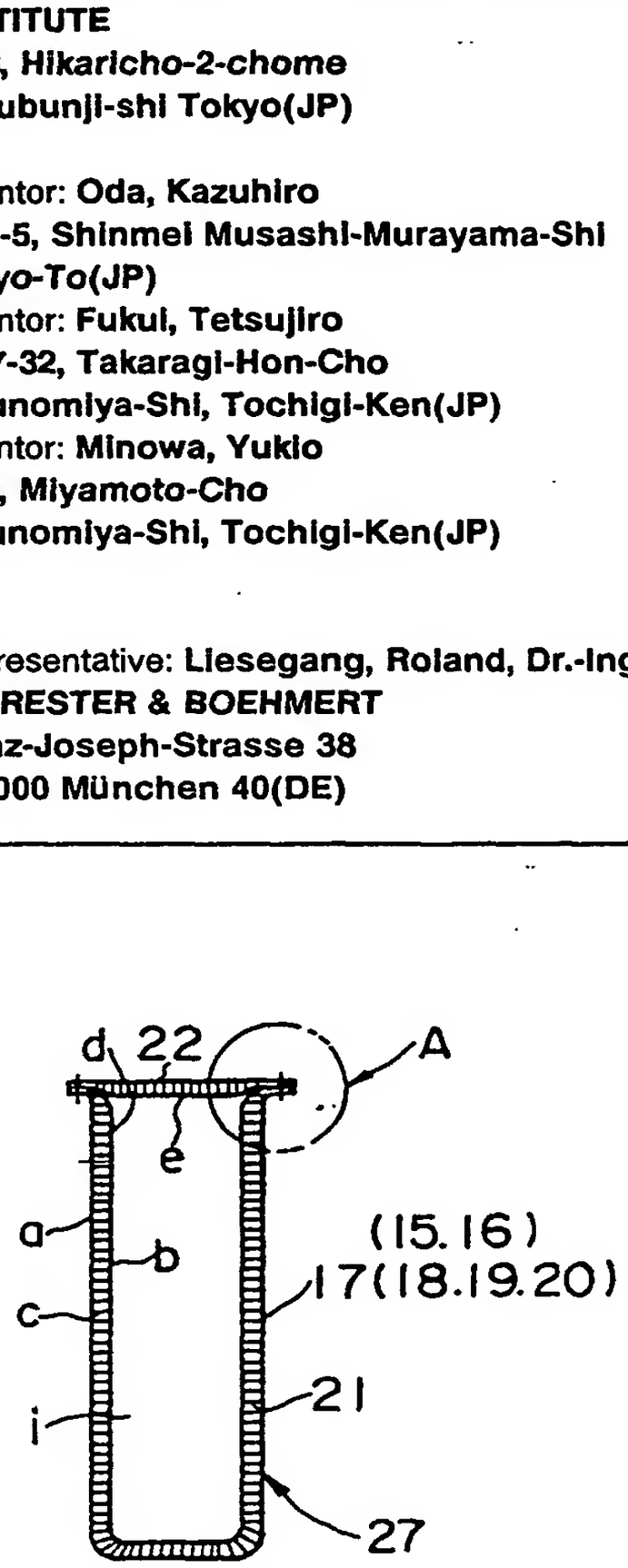

FIG. 4

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BACKGROUND OF THE INVENTION

The present invention relates to a bogie frame for a magnetically levitated vehicle or a railway vehicl for traveling on rails. The term "bogie" is herein used to designate a wheeled carriage which is also called a "truck".

Rolling stock bogie frames known heretofore have been fabricated principally of steel materials. The weight of the bogie frame accounts for a large proportion of the total weight of the bogie. As an effort to minimize the weight, a number of measures for reducing the weight have been proposed. Among such proposals are those relating to the use of aluminum alloys and fiber-reinforced plastic (FRP) materials for the bogie frames.

More specifically, FRP material containing carbon fibers or glass fibers for reinforcement are us d to fabricate long structural members, which are generally of tubular shape with rectangular cross section in the bogie construction of the type mentioned above. Hollows of the structural members are filled with foamed urethane. Thus core members are made. A plurality of the core members are assembled and wrapped with an FRP cover member to form main beams of the bogie frame. By this construction the bonding area between the core members and the covering FRP cover material is increased. As a result increased are tensile and shear strengths of the bogie frames. At the same time, the weight of the bogie frame is reduced. Such a construction is disclosed in Japanese Patent Appln. Laid-Open Publn. No. 62-264,935.

In another proposal for a rolling-stock bogie frame, FRP materials are used and a plurality of hollows are formed by means of spaced parallel webs fixed within each of elongated tubular members of rectangular cross section. Each hollow is filled with a filling material comprising fiber strands and foamed urethane. An object of the construction is reduction of the weight of the bogie frame. The above proposal is disclosed in Japanese Patent Appln. Laid-Open Publn. No. 62-244,755.

In a rolling-stock bogie frame of still another proposal, beam members are fabricated from elongated tubular members of rectangular cross section made of a carbon-fiber reinforced plastic material and filled with a filling material. By this construction, reduction in weight is sought. The construction is disclosed in Japanese Patent Appln. Laid-Open Publn. No. 61-143,257.

In each of the proposed bogie frames described above, each main beam member comprises an elongated tubular member of rectangular cross section made of an FRP material, and a filling material inserted into the tubular member. The construction of the known proposal aims at reduction in weight by using relatively thin outer sheathing in comparison with the case of bogie frames with hollows without the filling material. For this reason, the proportion of the filling material relative to the total weight becomes large. Moreover, the interiors of the bogie frame beams cannot be utilized for such purposes as accommodating an air tank or an air pipe for the pneumatic shock absorbing system.

SUMMARY OF THE INVENTION

Accordingly, in order to overcome the above described problems, it is an object of the present invention to provide a rolling-stock bogie frame in which the principal structural members are constructed to have hollows whereby equipment space for accommodating such items as an air tank or reservoir and piping is obtained, and at the same time the strength of the bogie frame is increased while its weight is reduced.

According to the present invention, there is provided a bogie frame of rolling stock, having a side beam and a cross beam integrally connected to the side beam to form a frame structure, a bearing box connected to the cross beam and an axle rotatably supporting a wheel via a connecting lever, each of said side beam and cross beam comprising a trough-shaped part forming opposite side walls and a bottom of the beam and having an open upper end, and a reinforcing member secured to the trough-shaped part to cover and close said open upper end, said each beam being a closed box beam with a hollow, each of the trough-shaped parts and the reinforcing members comprising an outer sheathing of a fiber-reinforced plastic material, an inner sheathing of a fiber-reinforced plastic material spaced apart from the outer sheathing and provided to form a space therebetween, and a honeycomb structure disposed in the space and bonded to the inner surfaces of the outer and inner sheathings.

As described above, the construction of the bogie frame according to the present invention provides a large installation space within the hollow beams for accommodating items of equipment such as an air reservoir or tank and piping. Moreover the construction provides high strength and light weight.

A preferred embodiment of the present invention will become understood from the following detailed description referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of an embodiment of a rolling-stock bogie frame according to the

present invention;
FIG. 2 is a side view of the bogie frame shown in FIG. 1;
FIG. 3 is an end view of the bogie frame;
FIG. 4 is a cross sectional view showing a beam constituting an essential structural member of the bogie frame;
FIG. 5 is an enlarged sectional view of the part encircled by the chain line circle A in FIG. 4;
FIG. 6 is a plan view showing a ladder-form frame structure of the bogie frame;
FIG. 7 is side view of the frame structure of FIG. 6;
FIG. 8 is a cross section taken along the line VIII-VIII in FIG. 6;
FIG. 9 is an enlarged sectional view showing the manner in which brackets are mounted on the bogie frame; and
FIG. 10 is a perspective view of a mold used for forming the bogie frame.

DESCRIPTION OF THE PREFERRED EMBODIMENT -

Referring to FIGS. 1 through 3, reference numeral 1 designates a bogie frame of a rolling stock vehicle for traveling on rails 2. Air spring holders 3 are respectively mounted on the upper part of the bogie frame 1 at front and rear end parts and at left and right sides thereof. The air spring holders 3 hold respective air springs 5 through laminated rubber assemblies 4 interposed therebetween. The air springs 5 support articulatedly coupled vehicle bodies 6 and 7 resting thereon. The vehicle bodies 6 and 7 are coupled by coupling bars 8.

The bogie frame 1 is supported on a plurality of wheels 11 (four wheels in the present embodiment). Two of the wheels 11 forming a pair are fixed to a common axle 12 near the ends thereof. The extreme ends of the axle 12 are rotatably supported in respective bearing boxes 9. Each bearing box 9 is coupled by a connecting lever 10 to the bogie frame 1 at a part thereof in the vicinity of a respective one of the air spring holders 3. Each connecting lever 10 at a root or inner end thereof is integrally fixed to a bearing box 9. The outer end of each connecting lever 10 is pivotally connected by a horizontal pin 10a to a bracket 10b fixed to the bogie frame 1 near the respective air spring holder 3. Thus the integral combination of each bearing box 9 and the connecting lever 10 constitutes a lever which is swingable in a vertical plane about the pin 10a. Furthermore, above each bearing box 9, an axle spring support beam 13 is fixed at one end to a respectiv one air spring holder 3. The support beam 13 extends horizontally in a longitudinal direction and is fixed at the other end to the bogie frame 1. An axle spring 14 is interposed between and fixed to each bearing box 9 and the support beam 13 thereabove.

As shown in FIGS. 6 and 7, the bogie frame 1 is of a rigid ladder construction. It comprises two side beams 15 and 16 on opposite lateral sides and four cross beams 17, 18, 19, and 20 joined at ends thereof to the side beams 15 and 16. The side beams and cross beams have a substantially rectangular cross section as shown in detail in FIG. 4. Each beam has a trough-shaped part 27 with an open upper part d and a reinforcing member 22 serving to cover and close the open upper part d. The trough-shaped part 27 of each beam has an outer sheathing a and an inner sheathing b comprising laminations of FRP prepreg fabric and formed as an integral structure. A honeycomb structure 21 is inserted in laminated state and bonded in the interior space c between the outer and inner sheathings a and b of each beam. The honeycomb structure 21 is made of heat and pressure resistant, light material, such as a heat resistant synthetic resin and/or an aluminum alloy. As shown in FIG. 7, the honeycomb hollow spaces 21a of the structure 21 extend in the thickness direction of each beam.

As indicated in FIG. 5, the reinforcing member 22 also has an outer sheathing g and an inner sheathing h made of a FRP material. In the space e between the outer and inner sheathing g and h, a honeycomb structure 21 is inserted in laminated state and is bonded. The honeycomb structure 21 is also made of a light material such as a heat and pressure resistant aluminum alloy. The upper edges of the trough-shaped parts 27 of each of the side and cross beams 15 through 20 have upper end flanges f extending horizontally outward. The above mentioned reinforcing members 22 are provided with outwardly extended lateral edges 22a on opposite sides thereof. When each reinforcing member 22 is placed in position on the corresponding trough-shaped part 27, the lateral edges 22a of the member 22 are superposed on their respective upper end flanges f of the trough-shaped part 27 and may be removably fixed thereto with suitable fasteners. By removing the reinforcing member 22 from the trough-shaped part 27, the interior of the part 27 can be checked.

Each of the upper end flanges f is formed by overlapping and bonding together the upper parts of the outer and inner sheathings a and b of the pertinent trough-shaped part 27. Similarly, each of the lateral edges 22a is formed by overlapping and bonding together the outer and inner sheathings g and h thereof. Thus, the honeycomb structure 21 is not present in the connecting part between each flange f and its lateral edge 22a.

Various items of equipment such as bearings, axle springs, and electric motors must be installed

in the bogie frame 1. For mounting the items on the bogie frame 1, brackets 23 and the reinforcing plates 23a are used as shown in FIG. 9. The brackets 23 and reinforcing plates 23a are installed on the side b ams and cross beams 15 through 20. For this purpose, mounting holes 24 are formed in th beams. First, the hollow spaces of the honeycomb structure 21 around each mounting hole 24 to be formed is filled by "resin potting" with a reinforcing material 25 such as a resin. Thereafter the mounting hole 24 is formed. The bogie frame 1 can be fabricated by forming the side beams and cross beams 15 through 20 as an integral structure of the reinforced plastic material of the laminated FRP prepreg fabric. This can be accomplished by means of a male mold 26 as shown in FIG. 10.

More specifically, the bogie frame 1 is fabricated by laying up the above mentioned inner sheathing b, the honeycomb structure 21, and the outer sheathing a in that order on the male mold 26. A vacuum bag is then placed thereon as a cover. The entire assembly thus formed is then placed in an autoclave and subjected to pressure and heat, thereby being cured and formed.

Thus, according to the present invention, a bogie frame 1 is formed as an integral structure without joints with a fiber-reinforced plastic material of laminated FRP prepreg fabric as shown in FIG. 6 by means of the male mold 26. As a result the weight of the bogie frame is reduced. At the same time, the honeycomb structure 21 is fitted, as it is laminated, into the spaces c and e. For this reason, the various members are reinforced. Furthermore, the hollow spaces i in the various beam members as shown in FIG. 4 can be effectively utilized for accommodating items of equipment such as an air tank.

Because of restrictions imposed by considerations of design, the height of the cross section of a beam of the bogie frame of the present invention may be limited. In such a case, in order to satisfy the strength requirement, the trough-shaped part of the beam is made to have an ample thickness. In this case, honeycomb structure for preventing buckling may become unnecessary. Furthermore, in order to reduce the weight of a beam while increasing the section modulus, an effective measure is to increase the thickness at the upper and lower parts of the beam.

As described above, the bogie frame according to the present invention comprises side beams and cross beams of rectangular cross sections which is formed as an integral structure of a fiber-reinforced plastic material. The outer part and inner part of each of the beams are formed by outer and inner sheathings. Between each outer sheathing and the corresponding inner sheathing, honeycomb structure is inserted and bonded. Each of the side and cross beams of the construction comprises a trough-shaped part with an open upper part and a reinforcement member covering the open upper part and secured to th upper part of the trough-shaped part. Thus, each beam has a hollow. The hollow can be advantageously utilized as an equipment installation space for accommodating equipment such as an air tank. At the same time, the integral monocoque construction of the bogie frame affords high strength with low weight.

While the presently preferred embodiment of the present invention has been shown and described, it is to be understood that the disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention as set forth in the appended claims.

Claims

1. A bogie frame of rolling stock, having beams (15, 16, 17, 18, 19, 20) forming a frame structure (1), bearing boxes (9) connected by respective connecting levers (10) to said beams and rotatably supporting wheel axles (12), characterized in that each of said beams (15, 16, 17, 18, 19, 20) comprises:

   a trough-shaped part (27) forming opposite side walls and a bottom of the beam and having an open upper end (d); and

   a reinforcing member (22) secured to the trough-shaped part (27) to cover and close said open upper end, each beam thereby being a closed box beam with a utilizable hollow interior (i), each of the trough-shaped part and the reinforcing member comprising:

   an outer sheathing (a; g) of a fiber-reinforced plastic material;

   an inner sheathing (b; h) of a fiber-reinforced plastic material spaced apart from the outer sheathing thereby to form a space therebetween; and

   a honeycomb structure (21) disposed in said space and bonded to the inner surfaces of the outer and inner sheathings.

2. The bogie frame according to claim 1, characterized in that said inner and outer sheathings (a, b; g, h) are made from laminations of fiber-reinforced prepreg fabrics.

3. The bogie frame according to claim 1, characterized in that said honeycomb structure (21) is made of light metal.

4. The bogie frame according to claim 1, characterized in that said honeycomb structure (21) is made of a synthetic resin.

5. The bogie frame according to claim 1, characterized in that said reinforcing member (22) is removably secured to the trough-shaped part.

6. The bogie frame according to claim 1, characterized in that said open upper end (d) of the trough-shaped part (27) has flanges (f) and said reinforcing member (22) has lateral edges (22a), said flanges and edges being superposed to be secured to each other.

7. The bogie frame according to claim 6, characterized in that said flanges (f) are formed by overlapping and bonding together upper parts of the outer and inner sheathings (a, b) of the trough-shaped part (27).

8. The bogie frame according to claim 6, characterized in that said lateral edges (22a) are formed by overlapping and bonding together outer parts of the outer and inner sheathings (g, h) of the reinforcing member (22).

9. The bogie frame according to claim 1, characterized in that said honeycomb structure (21) has hollow interior spaces (21a) extending in a direction transverse to said outer and inner sheathings.

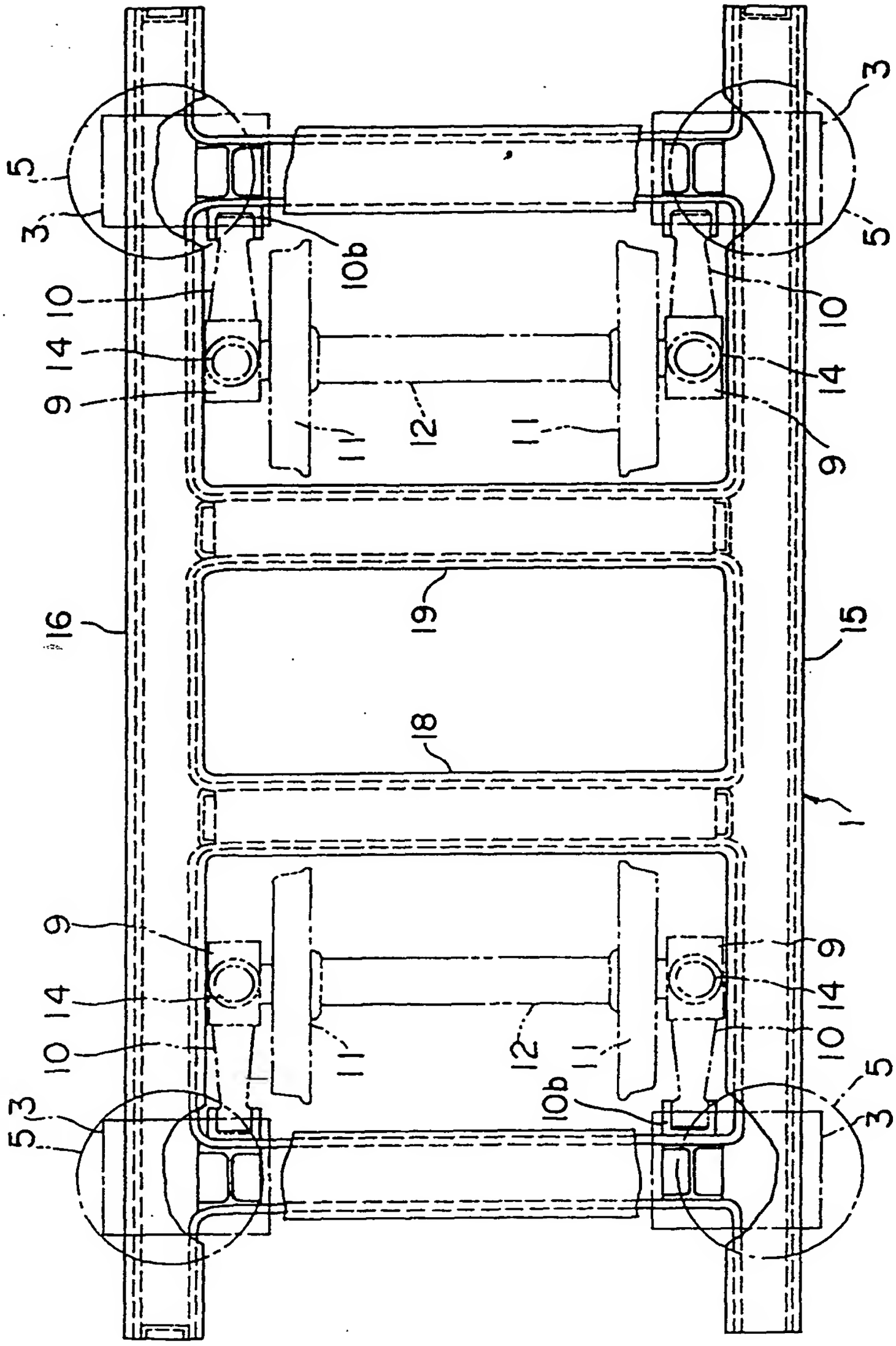
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FIG. 1

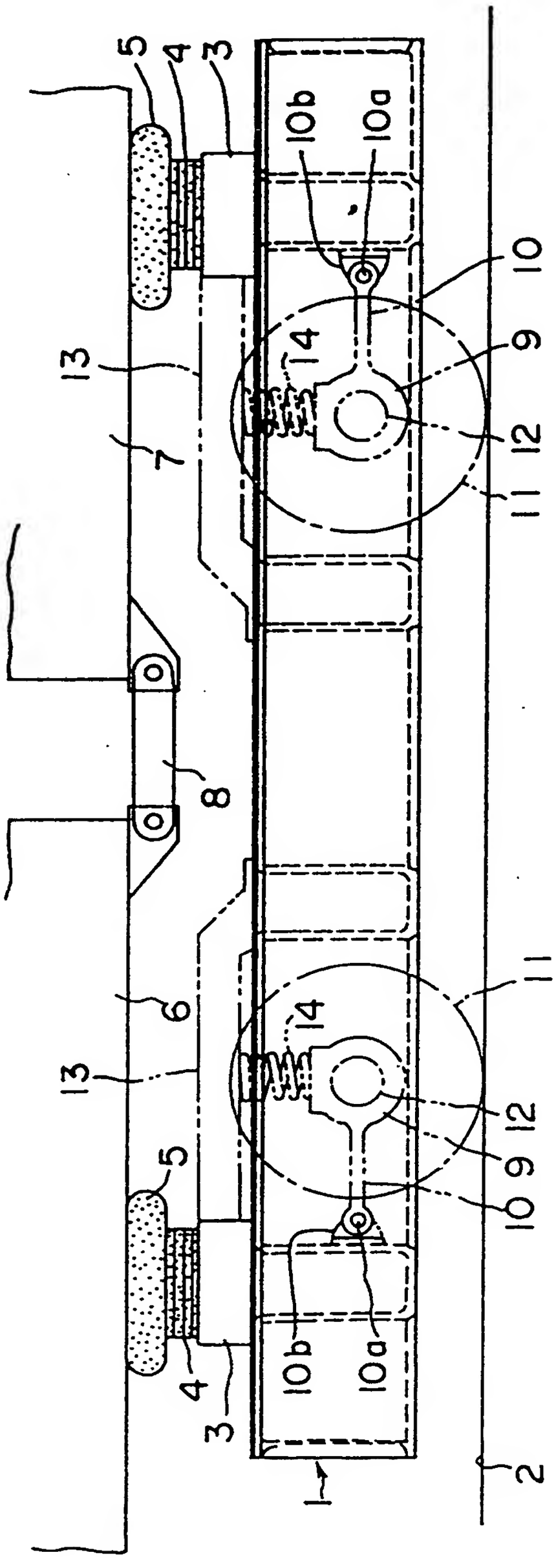

FIG. 2

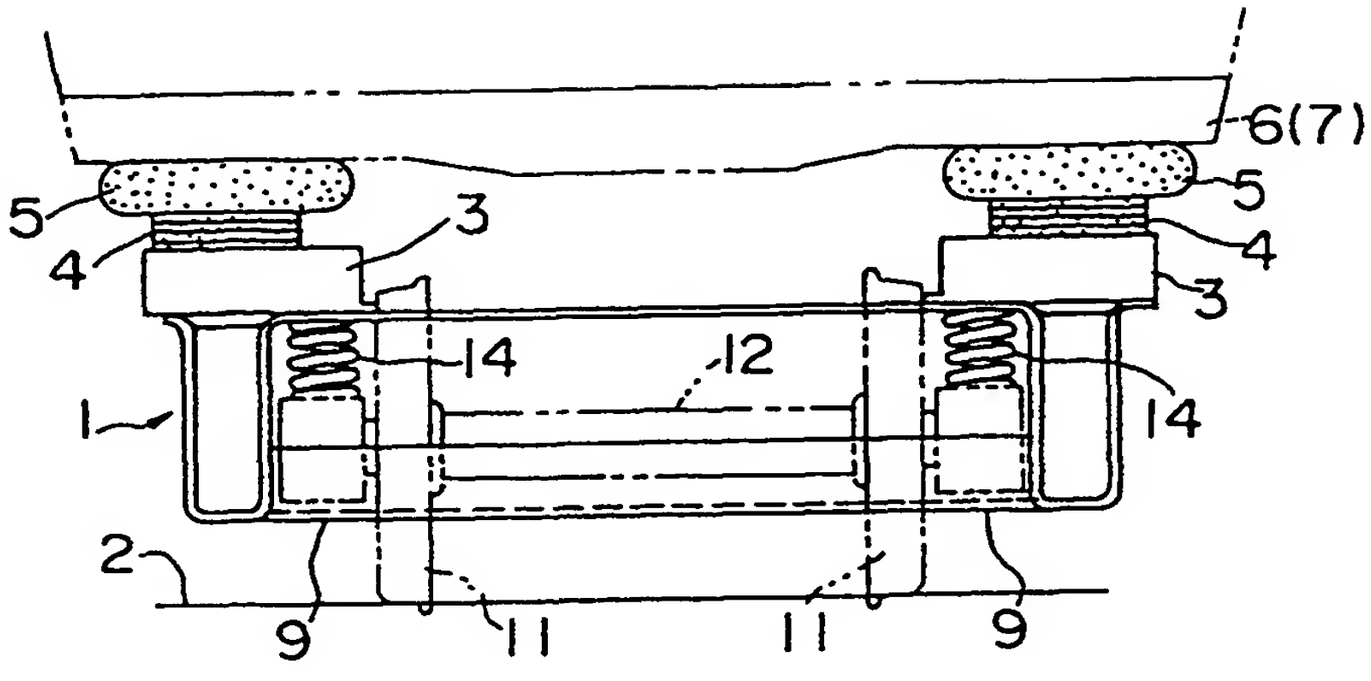

FIG. 3

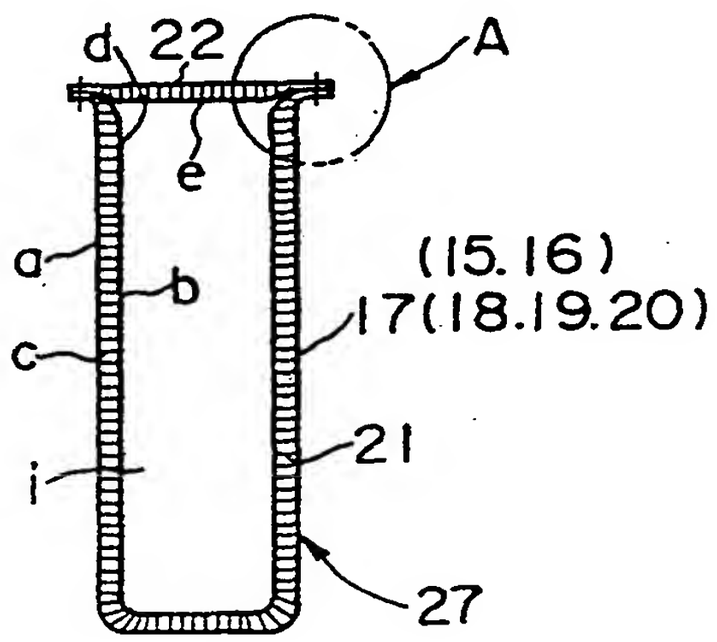

FIG. 4

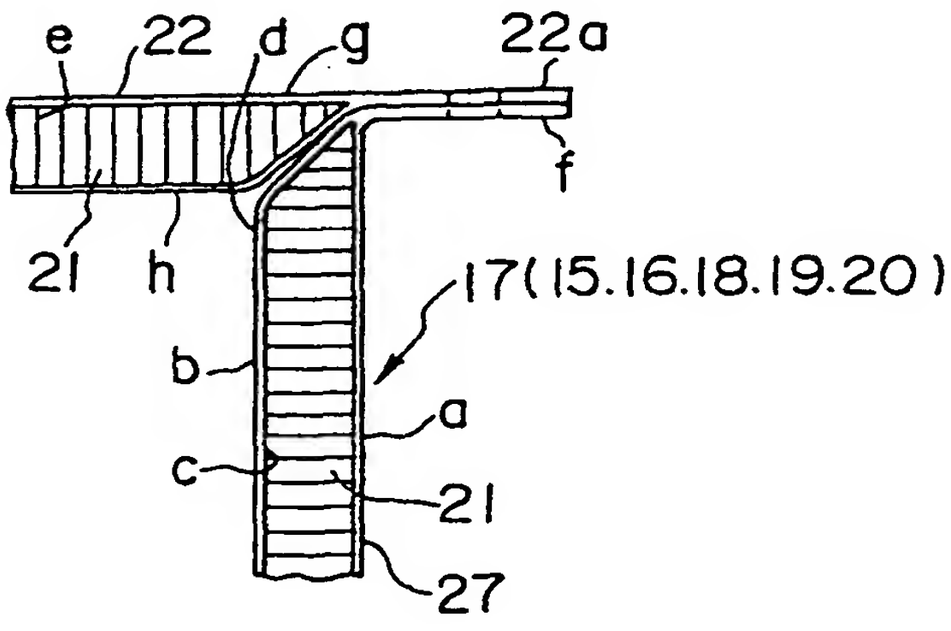

FIG. 5

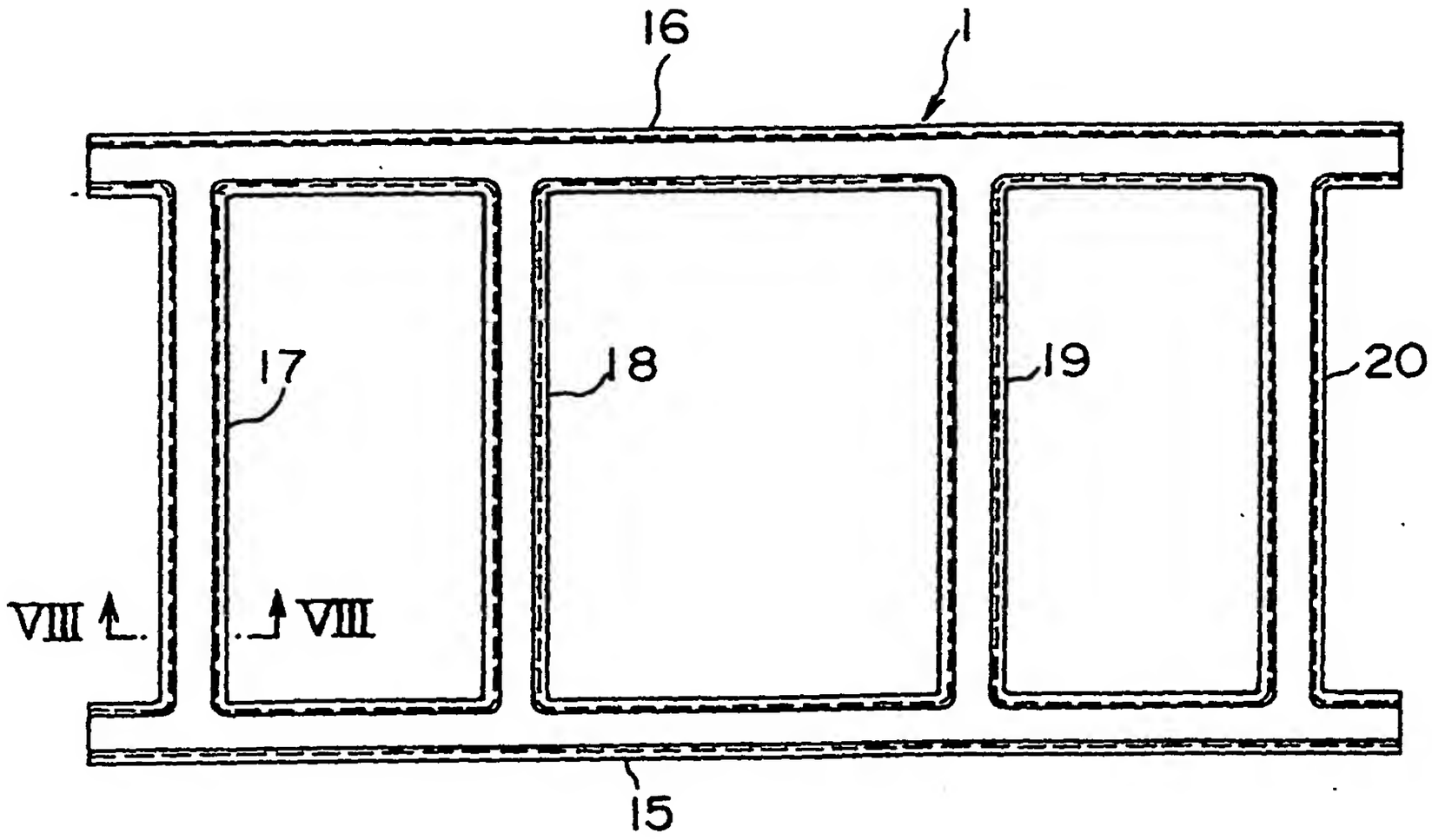

FIG. 6

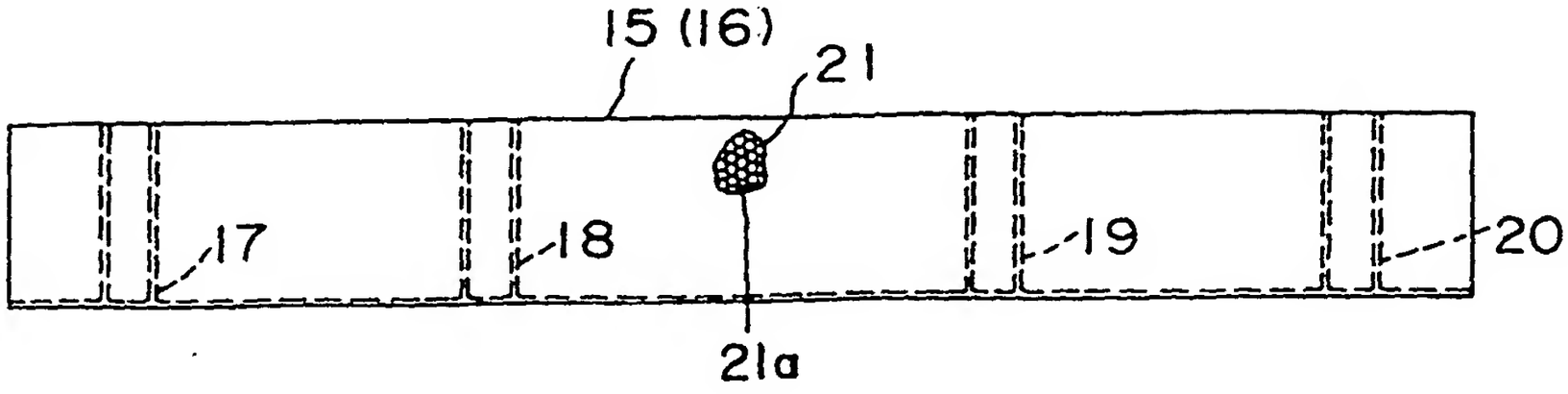

FIG. 7

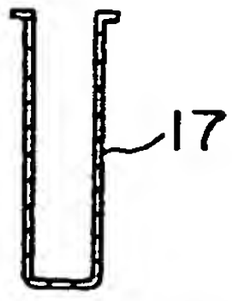

FIG. 8

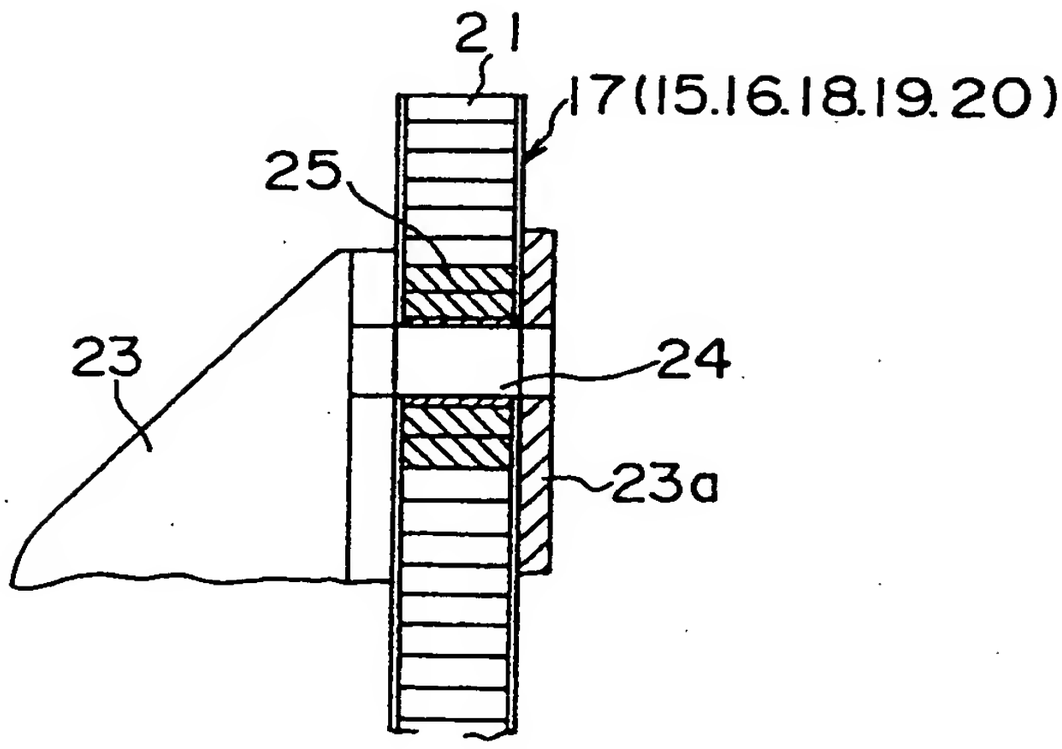

FIG. 9

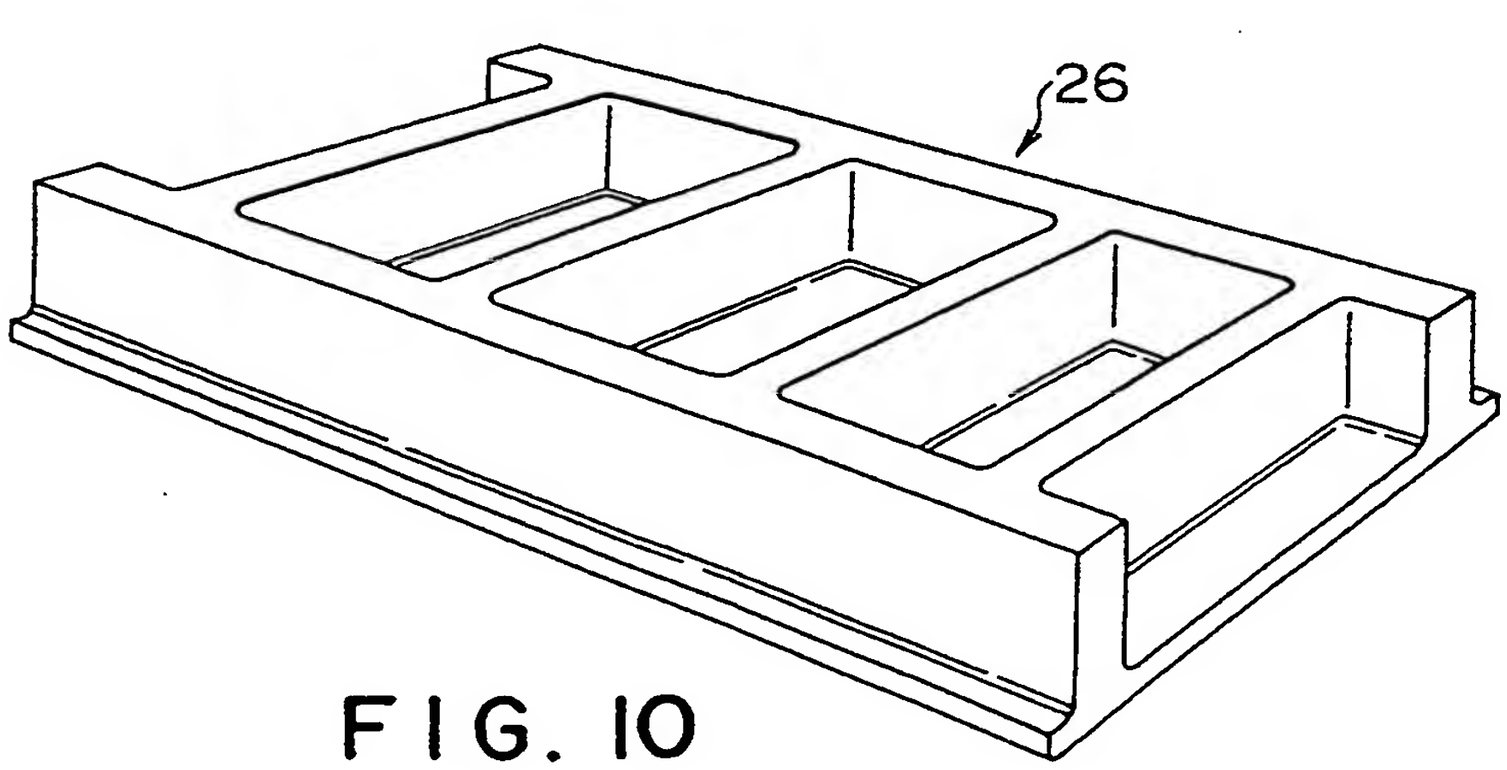

FIG. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 11 3239

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-2 908 230 (W. B. DEAN) * column 3, line 49 - column 4, line 13; figures 1,4-6 *	1	B61F5/52 B29D31/00
A	GB-A-746 010 (GENERAL MOTORS CORPORATION) * page 2, line 74 - line 102; figures 4,9,12 *	1	
A	FR-A-2 102 105 (M .KNEZ) * page 7, line 5 - line 18; figures 4-6 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B61F
B29D
B29C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 OCTOBER 1992	P. CHLOSTA

CATEGORY OF CITED DOCUMENTS

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